Limited Visual Dam Safety Inspection Summary Report

MA-070

Reservoir 20

Maui, Hawaii

Prepared by:

U.S. ARMY CORPS OF ENGINEERS
HONOLULU ENGINEER DISTRICT

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES

May 2006

Dam ID: MA-070
Name: Reservoir 20

Limited Visual Dam Safety Inspection Conducted on: 05 April 2006

I. Purpose:

Due to disaster occurrences of periodic heavy rains and flooding, which has caused extensive damage to property and loss of lives, the Governor has issued a State of Emergency Proclamation extending from February 20, 2006 to April 9, 2006. In light of the tragic failure of the Kaloko dam on Kauai and the continued forecast of heavy rains, emergency inspections of all regulated dams in all counties are being undertaken.

These inspections are for the purpose of determining if any of the regulated dams and reservoirs in the City and County of Honolulu, Maui County or Hawaii County, are suspect for immediate concern to the downstream area under the prolonged conditions of heavy rain showers.

II. Authority

Inspections are authorized under the Hawaii Dam Safety Act of 1987, Chapter 179D "Dams and Reservoirs" of Hawaii Revised Statues, and Title 13, Subtitle 7, Chapter 190, "Dams and Reservoirs" of the Hawaii Administrative Rules.

These inspections are being conducted under joint agreements of the U.S. Army Corps of Engineers (USACE), the U.S. Department of Agriculture Natural Resources Conservation Service (NRCS), and the State of Hawaii. The Memorandum of Agreement with the U.S. Army Corps of Engineers is entered into pursuant to 10 U.S.C. § 3036(d)(2), and the Intergovernmental Cooperation Act (31 U.S.C. §6505), and established via support agreement number DL-06-01.

III. Scope

Visual inspection will be made on parts of the embankment and appurtenant works readily available and visible for inspection by the inspection team at the time of the inspection. Such parts and appurtenant works would include the upstream slope, crest, downstream slope, abutments and toes, outlet works, and spillway.

On the date of this limited visual inspection, there may appear to be no immediate threat to the safety of the dam, however no assurance can be made regarding the dam's condition after this date. Subsequent adverse weather and other factors may affect the dam's condition.

IV. Limitations of Findings and Recommendations

The inspection is based only on visible features/areas of the dam on the day of inspection. The inspection does not entail detailed stability, hydrologic, hydraulic, or seismic investigations. This inspection is not a formal phase I or phase II dam safety inspection and does not include a review or evaluation from each specialist of an inspection team, such as a geologists, civil, geotechnical, structural, or hydraulics engineer. The owner should verify the findings of this report and take corrective actions. The owner may submit to the State alternative corrective actions that are certified by a licensed professional engineer in the State of Hawaii experienced in the design and construction of dams. This inspection does not relieve the owner/operator from their responsibility to conduct routine inspections, maintenance, repairs, modifications, monitoring, documentation, and/or investigative studies.

V. Inspection Team

Organization	Name /Title
U.S. Army Corps of Engineers	John Dillon, P.E. Geotechnical Engineer
State of Hawaii, Dept. of Land and Natural Resources	Curtis Powers DNLR, Engineering Division

VI. Owner's Representatives Present

Hawaiian Commercial and Sugar Company	Clyde Anakalea Rodney Chin

VII. Summary Report Team

Organization	Name
U.S. Army Corps of Engineers	Derek Chow Bill Empson
State of Hawaii, Dept. of Land and Natural Resources	Denise Manuel Edwin Matsuda

VIII. Dam Type

The dam appeared to be an earthen embankment dam.

IX. Dam Classification

The current hazard classification of this dam is: High

Hazard Potential Classification based on the following:

Category	Loss of Life	Economic Loss
Low	None Expected	Minimal (undeveloped to occasional structures or agriculture)
Significant	Few (No Urban development and no more than a small number of inhabitable structures)	Appreciable (Notable agriculture, industry or structures)
High	More than a few	Extensive community, industry or agriculture.

Based on inventoried storage and height data, the size classification of the dam is: Small

Size Classification based on the following:

Category	Storage (Acre-Feet)	Height (feet)
Small	< 1000	< 40
Intermediate	> 1000 and < 50,000	> 40 and < 100
Large	> 50,000	> 100

X. Summary of Inspection

Condition Rating Criteria: The conditional terms in this report are used to generally describe the conditions below. Inspections, monitoring, and additional investigations are considered to be incidental to all condition ratings.

Satisfactory	Expected to fulfill intended function.
Fair	Expected to fulfill intended function, but maintenance is recommended.
Poor	May not fulfill intended function; maintenance or repairs are necessary.
Unsatisfactory	Is not expected to fulfill intended function; repair, replacement, or modification is necessary.
Unknown	Not visible, not accessible, not inspected, or unable to determine the condition rating based on the observation taken.

Dam ID: MA-070
Name: Reservoir 20

A. General appearance:

The earthen dam and reservoir is used for irrigation purposes. Trees are growing in various locations on the dam. Several dips were apparent on the dam crest. No recent improvements or modifications were apparent.

Modifications / Improvements: There were no signs of any recent modifications.

Findings and Corrective Actions:

a. The Owner shall maintain documentations including Construction plans, specifications, improvements, modifications, Operations and Maintenance Manuals and routine inspection logs for this dam facility.
b. An EAP is required for High Hazard Dams. Submit an updated EAP for this facility.
c. Submit narrative and additional information detailing the improvements, modifications, and/or alterations at the dam site, unless covered by approved dam permit.
d. Routine inspection logs were not inspected.
e. Dam owners shall provide for routine inspection of the dam.
f. The dam did not appear to be maintained on a regular basis.
g. Access to site appears to be satisfactory.
h. Provide a detailed narrative of the incident, responses taken, and any damages incurred. Dam owners are required to promptly advise the department of any sudden or unprecedented flood or unusual or alarming circumstance or occurrences, which may adversely affect the dam or reservoir.
i. Submit current Operations and Maintenance Manual or Procedures for this dam / reservoir facility.
j. Submit Site or Facility Map of this Dam which identifies the location of major features including outlet works controls and conduits.
k. Emergency Alarms / Monitors: There were no alarms or monitors observed on this reservoir.
l. Power / Communication: There were no communication systems observed on this reservoir. There were no utility or power poles visible nearby.

B. Access / Security:

Access to the dam was accomplished via a County roadway. Access requires a 4-wheel drive vehicle.

Access to dam is questionable during severe weather conditions. Operational plans need to reflect this deficiency or access improved.

Security issues: Not inspected.

C. Intake Works: (Satisfactory)

There is one 3-ft by 10-ft gated concrete channel inlet feeding the reservoir. The intake has the ability to be shut off or diverted away from the reservoir during periods of heavy rains. This is done manually.

Findings and Corrective Actions:

a. The intake works were not tested.
b. The intake works appeared to be in satisfactory condition, no corrective actions are required at this time.

D. Reservoir: (Satisfactory)

The reservoir level during the inspection was 26'.
A wooden staff gage was observed.
According to staff personnel, the reservoir is normally operated between the ranges of 15' to 25'.

Findings and Corrective Actions:

a. The reservoir appeared to be in satisfactory condition, no corrective actions are required at this time.

E. Upstream Slope: (Fair)

The upstream slope varied in slope and ranged from a 2H to 1V (Horizontal/Vertical).
A partial rip rap slope protection was observed. Erosions were not visible; the slope was not entirely visible.
Cracks were not visible; the slope was not entirely visible.
Sinkholes were not visible; the slope was not entirely visible.

Findings and Corrective Actions:

a. The upstream slope appeared to be in fair to poor condition and requires corrective action.
b. The upstream slope was not visible due to high grass and vegetation. Clear high vegetation and maintain low to enable easy visual inspection.
c. Tree(s) were observed on the dam embankment. Trees have been identified as the probably cause of piping failures, and can possibly cause severe damage to the embankment if they are uprooted during high winds. Corrective action is required to remove the tree hazards from the dam. Acceptable remedies include removal of the tree and its root structure down to a 2" diameter and reconstructing the damaged embankment section. All repair work shall be accomplished as per the requirements of licensed geotechnical or structural engineer. Routinely monitor the damaged area for signs of settlement and seepage.

F. Crest: (Poor)

The dam crest was approximately 10 feet wide
There was no access to the crest.
Cracks were not observed, however the crest was not entirely visible.
Sinkholes were not observed, however there were several low areas on the crest.
Heavy vegetation was observed on the edges of the crest. These were primarily small woody vegetation and high grass.

Findings and Corrective Actions:

a. The dam crest appeared to be in fair to poor condition and requires corrective action.
b. Dips were observed on the crest, which requires further investigation to determine the underlining cause. Repair and monitor the area. Fill low areas to establish consistent crest elevation.
c. Portions of the crest were not visible due to high grass and bush vegetation. Clear high vegetation and maintain low to enable easy visual inspection.
d. Trees were observed along the dam crest. Trees have been identified as the probably cause of piping failures, and can possibly cause severe damage to the embankment if they are uprooted during high winds. Corrective action is required to remove the tree hazards from the dam. Acceptable remedies include removal of the tree and its root structure down to a 2" diameter and reconstructing the damaged embankment section. All repair work shall be accomplished as per the requirements of licensed geotechnical or structural engineer. Routinely monitor the damaged area for signs of settlement and seepage.
e. Monitor utility poles in crest.

G. Downstream Slope: (Fair)

The downstream slope was in fair to poor condition and not visible due to heavy vegetation. The slope was very steep, around a 1 to 1 slope.
There was access to the downstream slope via a roadway along the downstream toe.
Erosion was visible on the downstream slope as multiple ruts.
Sinkholes were not visible on the downstream slope, however the slope was not entirely visible.
Vegetation was observed on the downstream slope. The majority of the vegetation was woody trees ranging from 2" to 2 feet in diameter.
Seepage was not visible on the downstream toe, however the slope was not entirely visible.

Findings and Corrective Actions:

a. The downstream slope appeared to be in fair to poor condition and requires corrective action.
b. Gully erosion was observed on the slope, which requires maintenance and repair. Repair scarps.
c. The down stream slope was not visible due to high grass and bush vegetation. Clear high vegetation and maintain low to enable easy visual inspection.

d. Tree(s) were observed on the downstream slope. Trees have been identified as the probably cause of piping failures, and can possibly cause sever damage to the embankment if they are uprooted during a high winds. Corrective action is required to remove the tree hazards from the dam. Acceptable remedies include removal of the tree and its root structure down to a 2" diameter and reconstructing the damaged embankment section. All repair work shall be accomplished as per the requirements of licensed geotechnical or structural engineer. Routinely monitor the damaged area for signs of settlement and seepage.
e. The slope was very steep, around a 1 to 1 slope; further study is required to verify slope stability.
f. Utility poles at toe – potential piping path.

H. Abutments / Toe: (Fair)

The abutments and toe were not entirely visible or identifiable due to heavy vegetative growth.
Erosion along the abutment or toe was not visible.
Cracks in either direction were not visible, however the crest was not entirely visible.
There was heavy vegetation along the abutments and toe locations.

Findings and Corrective Actions:

a. The abutments/toe appeared to be in fair to poor condition and requires corrective action.
b. The abutment/toe area was not visible due to high grass and bush vegetation. Clear high vegetation and maintain low to enable easy visual inspection.
c. Trees were observed along the abutment/toe. Trees have been identified as the probably cause of piping failures, and can possibly cause severe damage to the embankment if they are uprooted during high winds. Corrective action is required to remove the tree hazards from the dam. Acceptable remedies include removal of the tree and its root structure down to a 2" diameter and reconstructing the damaged embankment section. All repair work shall be accomplished as per the requirements of licensed geotechnical or structural engineer. Routinely monitor the damaged area for signs of settlement and seepage.

I. Outlet Works: (Satisfactory)

The outlet works appeared to be a 24" steel pipe.
Not inspected in detail, not tested. The outlet works was controlled via a gate valve on the upstream side of the dam. Seepage was not visible flowing near the exit of the outlet works from the dam.

Findings and Corrective Actions:

a. The outlet works were not tested.
b. The outlet works appeared to be in satisfactory condition, no corrective actions are required at this time.

J. Spillway: (Fair)

This spillway consisted of a 3ft by 10ft channel.
The spillway channel then feeds a drainage swale that runs along the base of the downstream toe, toward the right embankment and then head downstream.
The spillway approach was clear.
There was no erosion observed near the spillway.
Further investigations should be conducted to conclude the capacity of the spillway.

Findings and Corrective Actions:

a. The spillway appeared to be in fair to poor condition and requires corrective action.
b. Unclear if spillway is adequately sized. Spillway should pass the probable maximum flood. Verify spillway capacity and take corrective action as required.

K. Down Stream Channel: (Unknown)

The down stream channel was not investigated.

Findings and Corrective Actions:

a. The downstream channel was not inspected.

XI. Additional Comments:

No immediate dam safety threats.
Woody vegetation and roots should be removed from dam.
Daily management of water levels is required to allow for safe operation of dam
Establish constant crest elevation.
Steep downstream slope and poles at toe are potential concerns. Homes immediately downstream of dam.
Several dips in crest up to 3' in depth – dips vary in size. Unsure of cause of dips.

PHOTOGRAPHS

MA-070 Maui Reservoir 20

MA-070 Maui Reservoir 20

070 crest

MA-070 Maui Reservoir 20

070 downstream slope – poles in embankment

MA-070 Maui Reservoir 20

070 downstream slope 2

MA-070 Maui Reservoir 20

070 downstream slope 3

MA-070 Maui Reservoir 20

070 downstream slope 4 – concrete spillway ditch

MA-070 Maui Reservoir 20

070 inlet

MA-070 Maui Reservoir 20

070 outlet

MA-070 Maui Reservoir 20

070 outlet 2

MA-070 Maui Reservoir 20

070 panoramic view 1

MA-070 Maui Reservoir 20

070 panoramic view 2

MA-070 Maui Reservoir 20

070 panoramic view 3

MA-070 Maui Reservoir 20

070 panoramic view 4

MA-070 Maui Reservoir 20

070 panoramic view 5

MA-070 Maui Reservoir 20

070 poles in slope

MA-070 Maui Reservoir 20

070 spillway

MA-070 Maui Reservoir 20

070 spillway entrance

MA-070 Maui Reservoir 20

070 structure on crest - base

MA-070 Maui Reservoir 20

070 structure on crest 2

MA-070 Maui Reservoir 20

070 upstream slope

FIELD INSPECTION SHEETS

Dam ID: MA-0070 RESERVOIR 20	Vulnerability Index: Extreme 1 High 2 Moderate 3 Low 4	Inspection No: _____ Date: 4/5/06

STATE OF HAWAII - DLNR
DAM SAFETY INSPECTION SHEET

Inspection Type: Visual Dam Safety Inspection

Persons Present	Affiliation	Phone Number
JOHN DILLON	US Army Corps of Engineers	
CURTIS POWERS	DLNR	
CLYDE ANAKALEA	HC&S	
RODNEY CHIN	HC&S	

Weather Condition: ☐ Rain previous day ☐ Rainy ☐ Drizzle / Mist ☐ Cloudy/Overcast ☒ Partly Cloudy ☐ Sunny ☐ Dry

Comments: _____

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1. General: *(Information currently on file, update as required)*

Dam/Res. Name	RESERVOIR 20		
Owner	Hawaiian Commercial & Sugar Company, a division of Alexander & Baldwin, Inc. *(C010)*		
Owner Contact	Mr. Randall Moore	Owner Ph.	
Lessee	N/A	Lessee Ph.	
O & M Contractor	HC&S	O & M Ph.	
Nearest Town	HALIIMAILL	Latitude	20.8733 ° (decimal)
County	MAUI	Longitude	156.3433 ° (decimal)
Tax Map Key(s)	(2)2-5-003:010		

Dam Status	A:	Hazard Potential	H:	Dam Size	
Year Completed	1913	Dam Length	1320 ft.	Dam Height	35 ft.
Normal Storage	134 ac.ft.	Max. Storage	165 ac.ft.	Max. Surface Area	9.8 ac.
Drainage Area	0.11 mi.	Spillway Type		Max. Spillway Q	39 cfs

Owner owns land under dam facility: _____

Emergency Action Plan on file with the Department: NO

Reports on file with the Department: May 1979 = Army Corps of Engineers, Initial Dam Safety Inspection / Survey (2)

Dam ID: MA-0070	Inspection No:
RESERVOIR 20	Date:

2. Questions for Owner's Rep.:

	Yes	No	Unknown	Comments
Construction Plans Available	☐	☒	☐	
Site / Facility Map	☒	☐	☐	
Operation & Maintenance Manual	☐	☒	☐	
Emergency Action Plan	☐	☒	☐	
Modifications / Improvements	☐	☐	☒	
Conduct Routine Inspections	☒	☐	☐	
Conduct Routine Maintenance	☐	☒	☐	
Vehicle access to site	☒	☐	☐	☐ Not accessible ☐ With Standard car ☒ Requires 4-Wheel Drive
Access during heavy rains	☒	☐	☐	☐ Not accessible ☐ With Standard car ☒ Requires 4-Wheel Drive
Access when spillway is flowing	☐	☐	☐	☐ Not accessible ☐ With Standard car ☒ Requires 4-Wheel Drive
Other Studies Conducted	☐	☐	☒	☐ Phase I ☐ Phase II ☐ Hydraulics ☐ Stability ☐ Hazard ☐ Seismic ☐ Other:
Incident History	☐	☒	☐	☐ Breached ☐ Overtop ☐ Slide ☐ Down stream Flooding ☐ Other:
Reservoir's Current Use	☐	☐	☐	☐ Sediment ☒ Irrigation ☐ Recreation ☐ Flood Control ☐ Drinking Water ☐ Power Generation ☐ Other:

Findings and Corrective Actions:

- ☒ a. The Owner shall maintain documentations including Construction plans, specifications, improvements, modifications, Operations and Maintenance Manuals and routine inspection logs for this dam facility.
- ☐ b. An Emergency Action Plan (EAP) is on file with the department, submit any updates as applicable.
- ☒ c. An EAP is required for High Hazard Dams. Submit an updated EAP for this facility.
- ☐ d. An EAP is recommended for all dams regardless of hazard class. Submit EAP if developed for the facility.
- ☒ e. Submit narrative and additional information detailing the improvements, modifications, and/or alterations at the dam site, unless covered by approved dam permit.
- ☒ f. Routine inspection logs were not inspected.
- ☒ g. Dam owners shall provide for routine inspection of the dam.
- ☒ h. The dam did not appear to be maintained on a regular basis.
- ☐ i. Access to site appears to be satisfactory.
- ☐ j. There is no vehicular access to the dam site. Operational and emergency plans need to reflect this deficiency or access provided.
- ☐ k. Access to dam is questionable during severe weather conditions and/or spillway overflows. Operational plans and emergency plans need to reflect this deficiency or access provided.
- ☒ l. Provide a detailed narrative of the incident, responses taken, and any damages incurred. Dam owners are required to promptly advise the department of any sudden or unprecedented flood or unusual or alarming circumstance or occurrences which may adversely affect the dam or reservoir.
- ☒ m. Submit current Operations and Maintenance Manual or Procedures for this dam / reservoir facility.
- ☐ n. Submit Site or Facility Map of this Dam which identifies the location of major features including outlet works controls and conduits.
- ☐ o. _____

Additional Requirements:

The following investigative study(s) are:

Required	Recommended	
☐	☐	Phase I Study
☐	☐	Phase II Study (Including ☐ Seepage ☐ Hydrology/Hydraulics ☐ EAP)
☐	☐	Hydrology and Hydraulics (including Probable Maximum Flood and spillway capacity)
☐	☐	Stability Analysis
☐	☐	Seismic Analysis
☐	☐	Hazard Classification
☐	☐	Other: _____

Dam ID: MA-0070 RESERVOIR 20	Inspection No: _____ Date: _____

Physical Dam Features: (Check All Applicable. Provide description of Items Observed and/or Take Photos. Indicate photo # in description.)

3. Reservoir:

Level during inspection 26' ft per _____ (gage / other)

Normal Operating Level/Range 15'-25' ft per _____ (gage / other)

Description: _____

Typical Operation ☐ Spillway always flowing ☒ Kept within normal range ☐ Kept Empty ☐ Drained Daily ☐ Only filled by Storms

☐ Other: _____

Sinkhole in Res.: ☐ # Observed: _____ Size: _____ by _____ in. Deep ☒ Not Visible ☐ None Observed

Description: _____

Staff Gage: Description: WOODEN

Findings:

- ☐ a. The reservoir was not inspected.
- ☒ b. The reservoir appeared to be in satisfactory condition, no corrective actions are required at this time.
- ☐ c. The reservoir appeared to be in fair to poor condition and requires corrective action.
- ☐ d. The reservoir appeared to be in unsatisfactory condition, urgent corrective action is required.

Corrective Actions:

- ☐ e. The staff gage needs maintenance and/or repair. Description: _____
- ☐ f. A staff gage was not observed at the reservoir. Provide some method of quantifying the water level within the reservoir.
- ☐ g. A sinkhole was observed in the upstream reservoir. Conduct additional investigations and monitoring to identify the cause, risk and appropriate action.
- ☐ h. _____

4. Intake Works Description:

☒ Number of Intakes 1

☐ Intake Culvert / Pipe

Size: _____ in. ☐ DIP ☐ Corrugated Metal ☐ PVC ☐ HDPE ☐ Concrete ☐ Other _____

Control: ☐ Gate ☐ Valve ☐ Flow can either be Shut off or Bypassed

From: ☐ Stream Diversion ☐ Pump ☐ Reservoir ☐ Other _____

☒ Ditch / Flume

Dimension: 3'x10' (Size x Depth) Shape RECT

Surface: ☐ Dirt ☐ Wood ☒ Concrete ☐ Lined w/_____

Control: ☒ Gate ☐ Valve ☒ Flow can either be Shut off or Bypassed

From: ☐ Stream Diversion ☐ Pump ☐ Reservoir ☒ Other IRR DITCH

Findings:

- ☐ a. The intake works were not inspected.
- ☒ b. The intake works were not tested.
- ☒ c. The intake works appeared to be in satisfactory condition, no corrective actions are required at this time.
- ☐ d. The intake works appeared to be in fair to poor condition and requires corrective action.
- ☐ e. The intake works appeared to be in unsatisfactory condition, urgent corrective action is required.

Corrective Actions:

- ☐ f. The intake works needs maintenance and/or repair. Description: _____
- ☐ g. _____

Dam ID: MA-0070 RESERVOIR 20	Inspection No: _____ Date: _____

5. Upstream Slope: **(Typical Slope ± 1 : 2)**

Slope Protection: ☐ None ☐ Dumped Rock ☒ Fitted Rip Rap ☐ Grouted Rip Rap ☐ Liner _____ ☐ Other: _____

☐ Defect in Protection: Description: PARTIAL RIPRAP

Erosion: ☐ Loose soil w/ little vegetation ☐ Rut (<6") ☐ Gully (>6" deep) ☒ Not Visible ☐ None Observed

Description: _____

Cracks: ☐ Parallel with crest ☐ Perpendicular to crest ☐ Slide visible ☒ Not Visible ☐ None Observed

Description: _____

Sinkholes: ☐ # Observed: _____ Size: _____ and _____ Depth ☒ Not Visible ☐ None Observed

Description: _____

Vegetation: ☐ None ☐ Low Ground Cover ☒ Bushes or Tall Grass ☒ Trees # SEVERAL ☐ <6" ☐ >6" & <20" ☐ >20"

Description: _____

Findings:

- ☐ a. The upstream slope was not inspected.
- ☐ b. The upstream slope appeared to be in satisfactory condition, no corrective actions are required at this time.
- ☒ c. The upstream slope appeared to be in fair to poor condition and requires corrective action.
- ☐ d. The upstream slope appeared to be in unsatisfactory condition and not expected to fulfill its intended function. Urgent corrective action is required.

Corrective Actions:

- ☐ e. Slope protection needs maintenance or repair. Description: _____
- ☐ f. Rut and/or Gully erosion was observed on the slope, which requires maintenance and/or repair. Description: _____
- ☐ g. A crack was observed on the slope, which requires further investigation to determine the underlining cause. Monitor the area and/or repair as required.
- ☐ h. A sinkhole was observed on the slope, which requires further investigation to determine the underlining cause. Repair and monitor the area.
- ☒ i. The upstream slope was not visible due to high grass and bush vegetation. Clear high vegetation and maintain low to enable easy visual inspection.
- ☒ j. Tree(s) were observed on the dam embankment. Trees have been identified as the probably cause of piping failures, and can possibly cause sever damage to the embankment if they are uprooted during a high winds. Corrective action is required to remove the tree hazards from the dam. Acceptable remedies include removal of the tree and its root structure down to a 2" diameter and reconstructing the damaged embankment section. All repair work shall be accomplished as per the requirements of licensed geotechnical or structural engineer. Routinely monitor the damaged area for signs of settlement and seepage.
- ☐ k. _____

Dam ID: MA-0070 RESERVOIR 20	Inspection No: _____ Date: _____

6. Crest: Approximate Crest Width: 10'

Access: ☒ None ☐ Walking Path ☐ Roadway, Surface / Width / Usage: _____

Erosion: ☐ Loose soil w/ little vegetation ☐ Rut (<6") ☐ Gully (>6" deep) ☒ Not Visible ☐ None Observed

Description: _____

Cracks: ☐ Parallel with crest ☐ Perpendicular to crest ☐ Slide visible ☒ Not Visible ☐ None Observed

Description: _____

Sinkholes: ☒ _____ in. Wide x _____ in. Long x _____ in. Deep ☐ Not Visible ☐ None Observed

Description: SEVERAL LOW AREAS UP TO 3" IN DEPTH - VARY IN LENGTH & WIDTH

Vegetation: ☐ None ☐ Low Ground Cover ☒ Bushes or Tall Grass ☒ Trees # SEVERAL ☒ <6" ☐ >6" & <20" ☐ >20"

Description: _____

Findings:

- ☐ a. The dam crest was not inspected.
- ☐ b. The dam crest appeared to be in satisfactory condition, no corrective actions are required at this time.
- ☒ c. The dam crest appeared to be in fair to poor condition and requires corrective action.
- ☐ d. The dam crest appeared to be in unsatisfactory condition and not expected to fulfill its intended function. Urgent corrective action is required.

Corrective Actions:

- ☐ e. Access along the crest was satisfactory.
- ☐ f. Access along the crest was not possible. Description: _____
- ☐ g. Rut and/or Gully erosion was observed on the crest, which requires maintenance and/or repair. Description: _____
- ☐ h. A crack was observed on the crest, which requires further investigation to determine the underlining cause. Monitor the area and/or repair as required.
- ☒ i. A sinkhole was observed on the crest, which requires further investigation to determine the underlining cause. Repair and monitor the area. (low area)
- ☒ j. Portions of the crest were not visible due to high grass and bush vegetation. Clear high vegetation and maintain low to enable easy visual inspection.
- ☒ k. Tree(s) were observed along the dam crest. Trees have been identified as the probably cause of piping failures, and can possibly cause sever damage to the embankment if they are uprooted during a high winds. Corrective action is required to remove the tree hazards from the dam. Acceptable remedies include removal of the tree and its root structure down to a 2" diameter and reconstructing the damaged embankment section. All repair work shall be accomplished as per the requirements of licensed geotechnical or structural engineer. Routinely monitor the damaged area for signs of settlement and seepage.
- ☒ l. UTILITY POLE & WOOD STRUCTURE ON CREST - MONITOR THESE AREAS

Dam ID: MA-0070
RESERVOIR 20

Inspection No: _____
Date: _____

7. Downstream Slope: (Typical Slope ± 1 : 1)

Access: ☒ lower roadway along toe ☐ roadway to outlet works ☐ walkway to outlet works ☐ None Observed

Slope Protection: ☒ None ☐ Dumped Rock ☐ Rip Rap ☐ Grouted Rip Rap ☐ Concrete

Erosion: ☐ Loose soil w/ little vegetation ☐ Rut (<6") ☒ Gully (>6" deep) ☐ Not Visible ☐ None Observed

Description: MULTIPLE RUTS

Cracks: ☐ Parallel with crest ☐ Perpendicular to crest ☐ Slide visible ☒ Not Visible ☐ None Observed

Description: _____

Sinkholes: ☐ _____ in. Wide x _____ in. Long x _____ in. Deep ☒ Not Visible ☐ None Observed

Description: _____

Vegetation: ☐ None ☐ Low Ground Cover ☒ Bushes or Tall Grass ☒ Trees # SEVERAL ☐ <6" ☐ >6" & <20" ☐ >20"

Description: _____

Seepage:

Seep Spot Number 1

☐ Green Vegetation ☐ Wet or Muddy Ground ☐ Ponding Water ☒ Not Visible ☐ None Observed

☐ Flowing, Description: _____

Water Clarity: ☐ Clear ☐ Some particles ☐ Muddy ☐ Other: _____

Description: _____

Seep Spot Number 2

☐ Green Vegetation ☐ Wet or Muddy Ground ☐ Ponding Water ☐ Not Visible ☐ None Observed

☐ Flowing, Description: _____

Water Clarity: ☐ Clear ☐ Some particles ☐ Muddy ☐ Other: _____

Description: _____

Findings:

☐ a. The downstream slope was not inspected.

☐ b. The downstream slope appeared to be in satisfactory condition, no corrective actions are required at this time.

☒ c. The downstream slope appeared to be in fair to poor condition and requires corrective action.

☐ d. The downstream slope appeared to be in unsatisfactory condition and not expected to fulfill its intended function. Urgent corrective action is required.

Corrective Actions:

☐ e. Slope protection needs maintenance or repair. Description: _____

☒ f. Rut and/or Gully erosion was observed on the slope, which requires maintenance and/or repair. Description: _____

☐ g. A crack was observed on the slope, which requires further investigation to determine the underlining cause. Monitor the area and/or repair as required.

☐ h. A sinkhole was observed on the slope, which requires further investigation to determine the underlining cause. Repair and monitor the area.

☒ i. The down stream slope was not visible due to high grass and bush vegetation. Clear high vegetation and maintain low to enable easy visual inspection.

☒ g. Tree(s) were observed on the downstream slope. Trees have been identified as the probably cause of piping failures, and can possibly cause sever damage to the embankment if they are uprooted during a high winds. Corrective action is required to remove the tree hazards from the dam. Acceptable remedies include removal of the tree and its root structure down to a 2" diameter and reconstructing the damaged embankment section. All repair work shall be accomplished as per the requirements of licensed geotechnical or structural engineer. Routinely monitor the damaged area for signs of settlement and seepage.

☐ h. Seepage/Ponding water was observed. Monitor and conduct further investigation to locate the source of water and extent of any possible hazardous or developing condition.

☐ i. Seepage was observed flowing and particles were observed to be removed by the flow. Take immediate action to stop the loss of soil from the embankment. Conduct further investigation to determine the underlining cause and take corrective action. Monitor the area.

☒ j. The slope was very steep, around a 1 to 1 slope, further study is required to verify slope stability.

☒ k. UTILITY POLE @ TOE - POTENTIAL PIPING PATH.

Dam ID: MA-0070 RESERVOIR 20	Inspection No: _____ Date: _____

8. Abutments/Toe:

Erosion: ☐ Loose soil w/ little vegetation ☐ Rut (<6") ☐ Gully (>6" deep) ☒ Not Visible ☐ None Observed

Description: _____

Cracks: ☐ Parallel with crest ☐ Perpendicular to crest ☐ Slide visible ☒ Not Visible ☐ None Observed

Description: _____

Vegetation: ☐ None ☐ Low Ground Cover ☒ Bushes or Tall Grass ☒ Trees # SEVERAL ☒ <6" ☐ >6" & <20" ☐ >20"

Description: _____

Seepage:

Seep Spot Number 1

☐ Green Vegetation ☐ Wet or Muddy Ground ☐ Ponding Water ☒ Not Visible ☐ None Observed

☐ Flowing, Description: _____

Water Clarity: ☐ Clear ☐ Some particles ☐ Muddy ☐ Other: _____

Description: _____

Seep Spot Number 2

☐ Green Vegetation ☐ Wet or Muddy Ground ☐ Ponding Water ☐ Not Visible ☐ None Observed

☐ Flowing, Description: _____

Water Clarity: ☐ Clear ☐ Some particles ☐ Muddy ☐ Other: _____

Description: _____

Findings:

☐ a. The abutments/toe were not inspected.

☐ b. The abutments/toe appeared to be in satisfactory condition, no corrective actions are required at this time.

☒ c. The abutments/toe appeared to be in fair to poor condition and requires corrective action.

☐ d. The abutments/toe appeared to be in unsatisfactory condition and not expected to fulfill its intended function. Urgent corrective action is required.

Corrective Actions:

☐ e. Slope protection needs maintenance or repair. Description: _____

☐ f. Rut and/or Gully erosion was observed, which requires maintenance and/or repair. Description: _____

☐ g. A crack was observed along the abutments/near the toe, which requires further investigation to determine the underlining cause. Monitor the area and/or repair as required.

☒ h. The abutment/toe area was not visible due to high grass and bush vegetation. Clear high vegetation and maintain low to enable easy visual inspection.

☒ i. Tree(s) were observed along the abutment/toe. Trees have been identified as the probably cause of piping failures, and can possibly cause sever damage to the embankment if they are uprooted during a high winds. Corrective action is required to remove the tree hazards from the dam. Acceptable remedies include removal of the tree and its root structure down to a 2" diameter and reconstructing the damaged embankment section. All repair work shall be accomplished as per the requirements of licensed geotechnical or structural engineer. Routinely monitor the damaged area for signs of settlement and seepage.

☐ j. Seepage/Ponding water was observed. Monitor and conduct further investigation to locate the source of water and extent of any possible hazardous or developing condition.

☐ k. Seepage was observed flowing and particles were observed to be removed by the flow. Take immediate action to stop the loss of soil from the embankment. Conduct further investigation to determine the underlining cause and take corrective action. Monitor the area.

☐ l. _____

Dam ID: MA-0070 RESERVOIR 20	Inspection No: _____ Date: _____

9. Outlet Works:

Culvert / Pipe

Type / Size: 1-24"

Culvert: ☐ Concrete ☐ Masonry ☐ unlined earth ☐ Other _____

Pipe: ☒ DIP ☐ Corrugated Metal ☐ PVC ☐ HDPE ☐ Concrete ☐ Other _____

Control Type: ☐ Gate ☒ Valve ☐ Other _____

Location: ☐ Control on Upstream side ☒ Control on Downstream side

Seepage: ☐ Green Vegetation ☐ Wet or Muddy Ground ☐ Ponding Water ☒ Not Visible ☐ None Observed

☐ Flowing, Description: _____

Water Clarity: ☐ Clear ☐ Some particles ☐ Muddy ☐ Other: _____

Description: _____

Findings:

- ☐ a. The outlet works were not inspected.
- ☒ b. The outlet works were not tested.
- ☒ c. The outlet works appeared to be in satisfactory condition, no corrective actions are required at this time.
- ☐ d. The outlet works appeared to be in fair to poor condition and requires corrective action.
- ☐ e. The outlet works appeared to be in unsatisfactory condition and not expected to fulfill its intended function. Urgent corrective action is required.

Corrective Actions:

- ☐ f. Seepage/Ponding water was observed. Conduct further investigation to locate the source of water and extent of any possible hazardous or developing condition.
- ☐ g. Seepage was observed flowing and particles were observed to be removed by the flow. Take immediate action to stop the loss of soil. Conduct further investigation to determine the underlining cause and take corrective action. Monitor the area. Failures caused by seepage/piping along the outlet conduit are very common and are considered to be a dangerous situation.
- ☐ h. Were not visible due to high grass and bush vegetation. Clear high vegetation and maintain low to enable easy visual inspection.
- ☐ i. _____
- ☐ j. _____

Dam ID: MA-0070
RESERVOIR 20

Inspection No: _____
Date: _____

10. Spillway:

Type: ☐ None ☐ Culvert/Pipe ☒ Channel

Description: _____

Dimension: 3'x15' ft. Invert elevation: 4½' BELOW CREST ft. per staff gage

Slope Protection: ☐ None ☐ Grass ☐ Dumped Rock ☐ Fitted Rip Rap ☐ Grouted Rip Rap ☒ Concrete

☐ Defect in Protection: Description: _____

Approach: ☒ Clear ☐ High Veg. ☐ Trees ☐ Other: _____

Erosion: ☐ Scour ☐ Gully ☐ Headcut ☒ Not Observed ☐ Other: _____

Description: _____

Vegetation: ☒ None ☐ Low Ground Cover ☐ Bushes or Tall Grass ☐ Trees #_____ ☐ <6" ☐ >6" & <20" ☐ >20"

Description: _____

Findings:

- ☒ a. The Spillway appeared to be in satisfactory condition, no corrective actions are required at this time.
- ☐ b. The Spillway appeared to be in fair to poor condition and requires corrective action.
- ☐ c. The Spillway appeared to be in unsatisfactory condition and not expected to fulfill its intended function. Urgent corrective action is required.

Corrective Actions:

- ☐ d. Slope protection needs maintenance or repair. Description: _____
- ☐ e. The spillway approach was blocked. Clear approach.
- ☐ f. Severe scour erosion was observed which requires maintenance and/or repair. Description: _____
- ☐ g. A headcut (vertical drop in channel due to erosion) was observed downstream of the spillway. Corrective action is required to prevent this problem from moving upstream.
- ☐ h. Trees are unacceptable in the spillway channel and approach. Take corrective action to address the woody vegetation problem and repair the damaged area.
- ☐ i. Unclear if spillway is adequately sized. Spillway should pass the probable maximum flood. Verify spillway capacity and take corrective action as required.
- ☐ j. _____

11. Down Stream Channel:

Name: _____

Downstream: ☐ Sump ☐ Open Area ☐ Un-Defined Drainage-way ☐ Defined Drainage-way ☐ Other _____

Items along Stream Bank: ☐ None ☐ Road ☐ Houses ☐ Town ☒ Not Inspected

Description: HOMES IMMEDIATELY D/S OF DAM.

Findings:

- ☒ a. The downstream channel was not inspected.
- ☐ b. The downstream channel appeared to be in satisfactory condition, no corrective actions are required at this time.
- ☐ c. The downstream channel appeared to be in fair to poor condition and requires corrective action.
- ☐ d. The downstream channel appeared to be in unsatisfactory condition and not expected to fulfill its intended function. Urgent corrective action is required.

Corrective Actions:

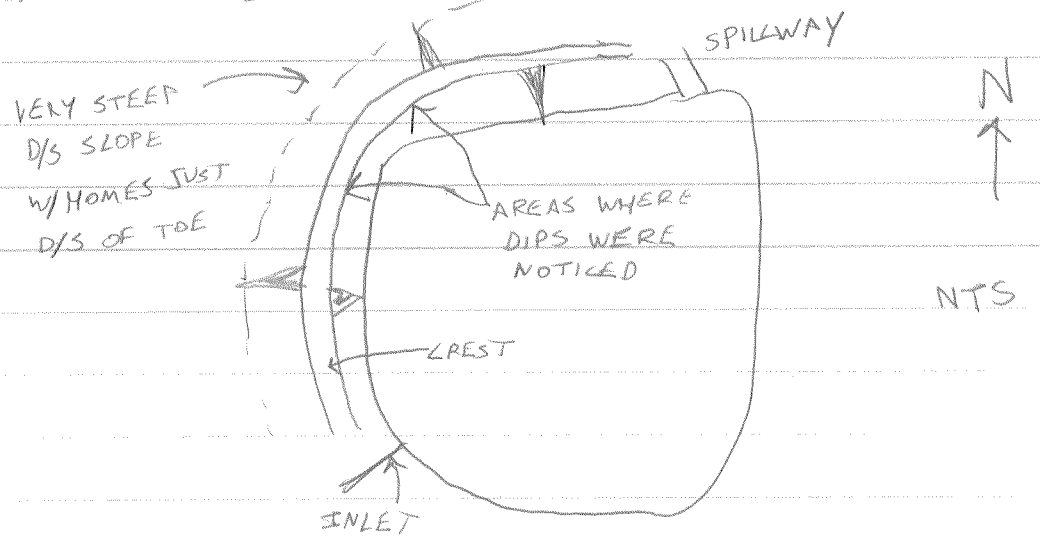
- ☐ e. _____

Dam ID: MA-0070 RESERVOIR 20	Inspection No: _____ Date: _____

Additional Comments:

On the date of this limited visual inspection, there appeared to be no immediate threat to the safety of the dam. No assurance can be made regarding the dam's condition after this date. Subsequent adverse weather and other factors may affect the dam's condition.

- NO IMMEDIATE DAM SAFETY THREATS
- WOODY VEGETATION & ROOTS SHOULD BE REMOVED FROM DAM.
- DAILY MANAGEMENT OF WATER LEVELS IS REQ'D TO ALLOW FOR SAFE OPERATION OF DAM.
- STEEP D/S SLOPE & POLE AT TOE ARE POTENTIAL CONCERNS. HOMES IMMEDIATELY D/S OF DAM.
- SEVERAL DIPS IN CREST UP TO 3' IN DEPTH - DIPS VARY IN SIZE.



Limitations and Intent of this Dam Safety Inspection:

This Dam Safety Inspection was conducted to assess the general overall condition of the reservoir/dam, identify visible deficiencies, and recommend areas of for monitoring, additional investigative studies and corrective actions. The inspection is based only on visible features/areas of the dam on the day of inspection. This inspection is not a formal phase I or phase II dam safety inspection and does not include a review or evaluation from each specialist of an inspection team, such as a geologists, civil, geotechnical, structural, or hydraulics engineer. The owner should verify the findings of this report and take corrective actions. The owner may submit to the State alternative corrective actions that are certified by a licensed professional engineer in the State of Hawaii experienced in the design and construction of dams. This inspection does not relieve the owner/operator from their responsibility to conduct routine inspections, maintenance, repairs, modifications, monitoring, documentation, and/or investigative studies. The inspection was conducted under the authority of the Hawaii Revised Statures Chapter 179D, and Hawaii Administrative Rules, Title 13, Chapter 190, titled "Dams and Reservoirs". Questions regarding this inspection should be forwarded to the Hawaii State Dam Safety Program; PO Box 373; Honolulu, Hawaii 96809; Ph. (808) 587-0236.

Revised: Dec. 1, 2003